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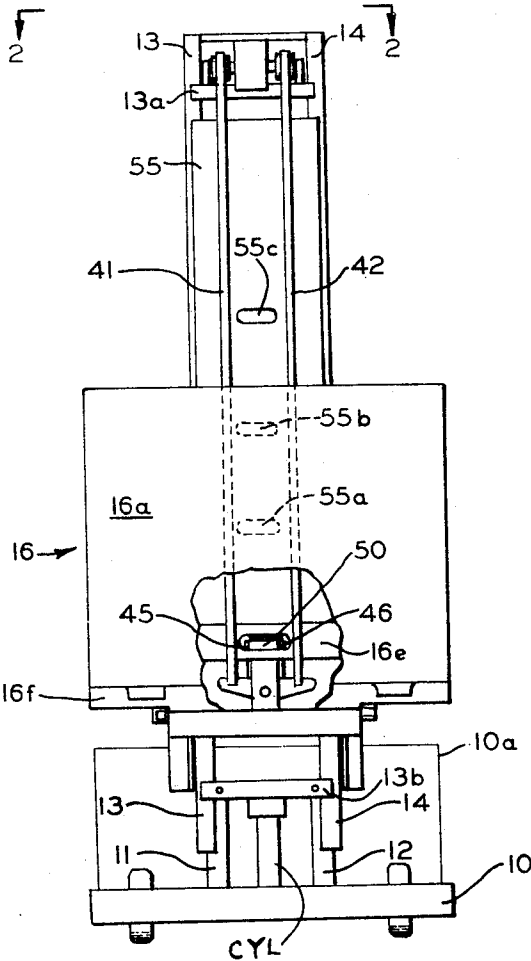
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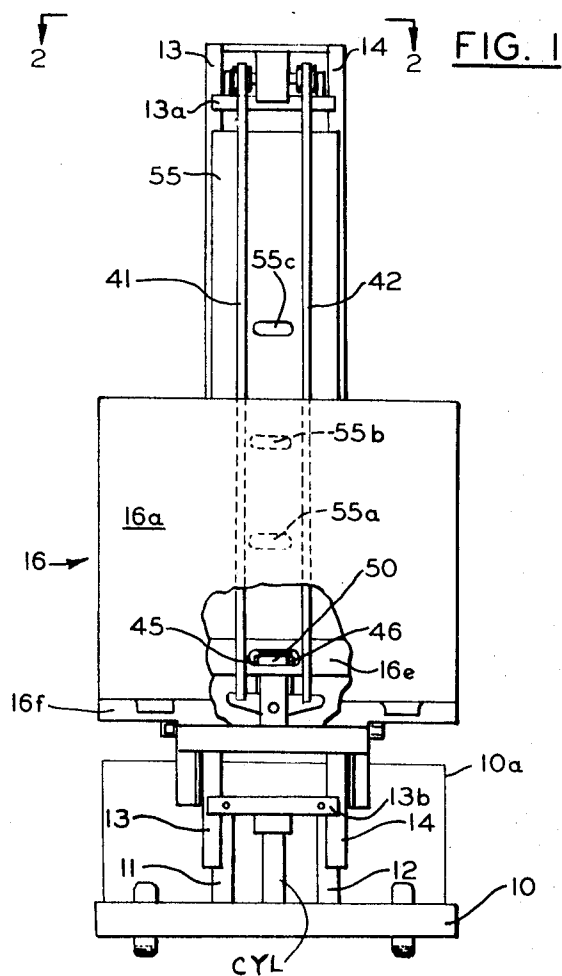
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[54] **LIFT TRUCKLOAD CARRIAGE SAFETY DEVICE**
10 Claims, 6 Drawing Figs.
[52] U.S. Cl. **187/84,**
187/82, 187/81, 188/189, 187/9
[51] Int. Cl. **B66b 5/16**
[50] Field of Search 187/9, 81,
82, 83, 84, 95, 13; 188/189

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ABSTRACT: A pair of load carriage lifting chains are connected to opposite ends of a rocker arm pivotally connected on the load carriage so that the rocker arm is maintained in a reference pivot position during normal operation, but rotated on one direction or the other upon failure of one or the other of the chains. Rotation of the rocker arm in either direction from the reference position urges a stop means perpendicular to the plane of the truck mast structure to engage one of a plurality of cooperating stop means spaced vertically along the mast structure to half free fall of the load carriage. Spring means normally overcome by the torques applied to the rocker arm by the two chains rotates the rocker arm to translate the stop means if both chains break substantially simultaneously.





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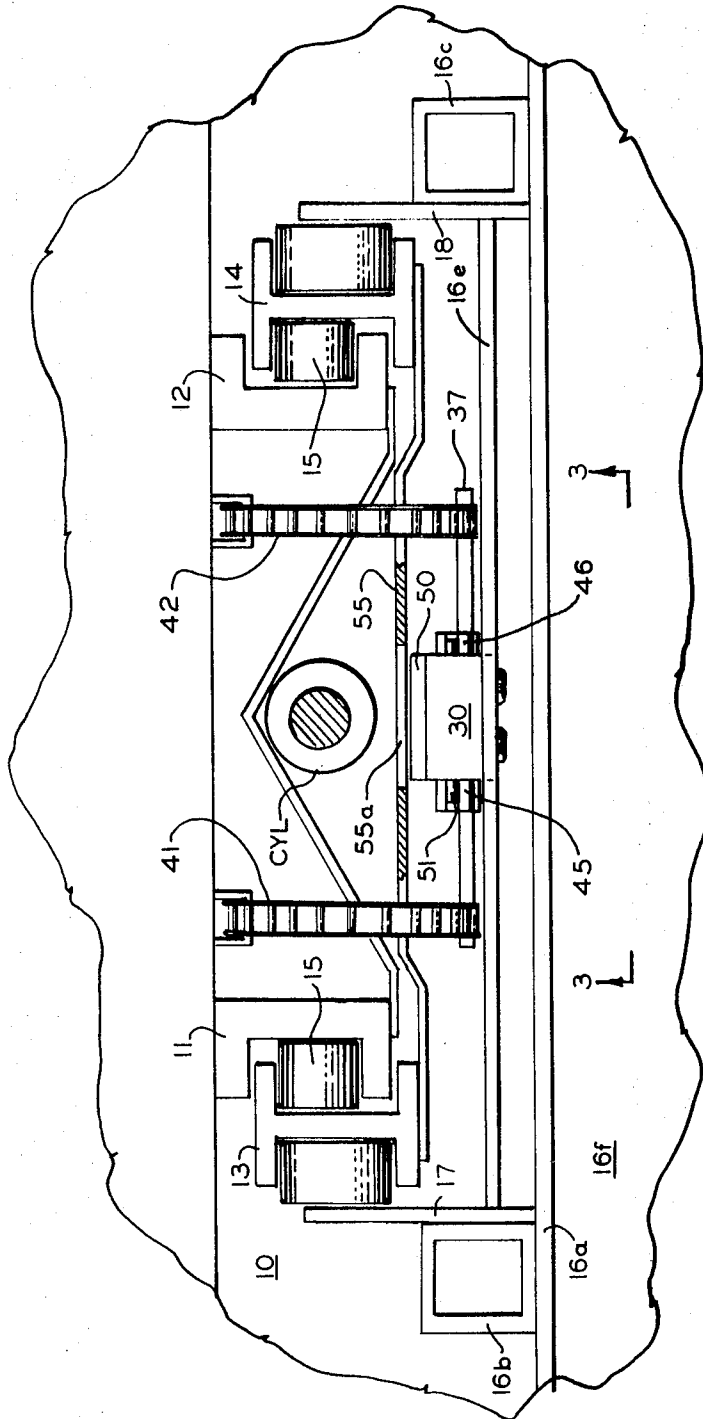


FIG. 2

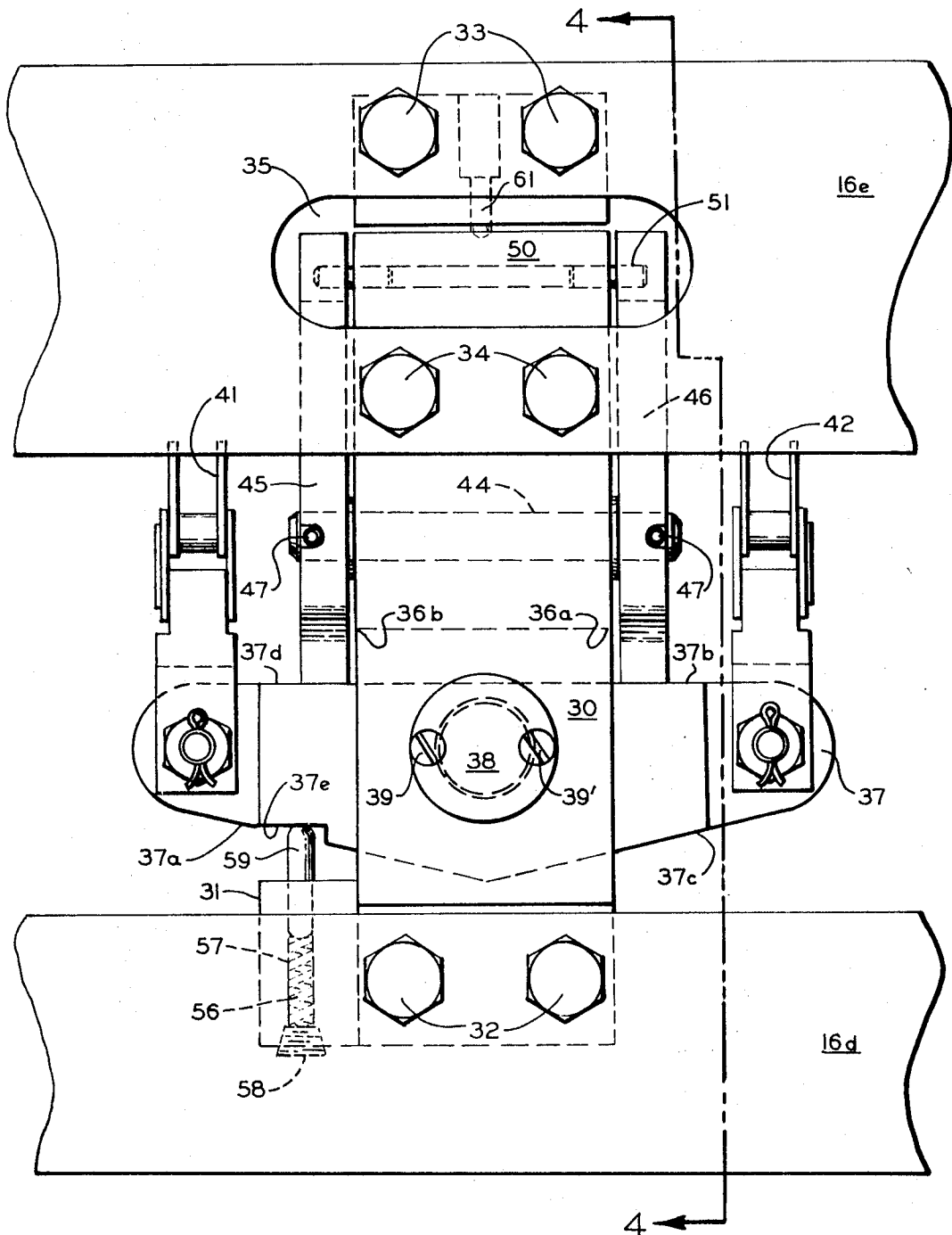


FIG. 3

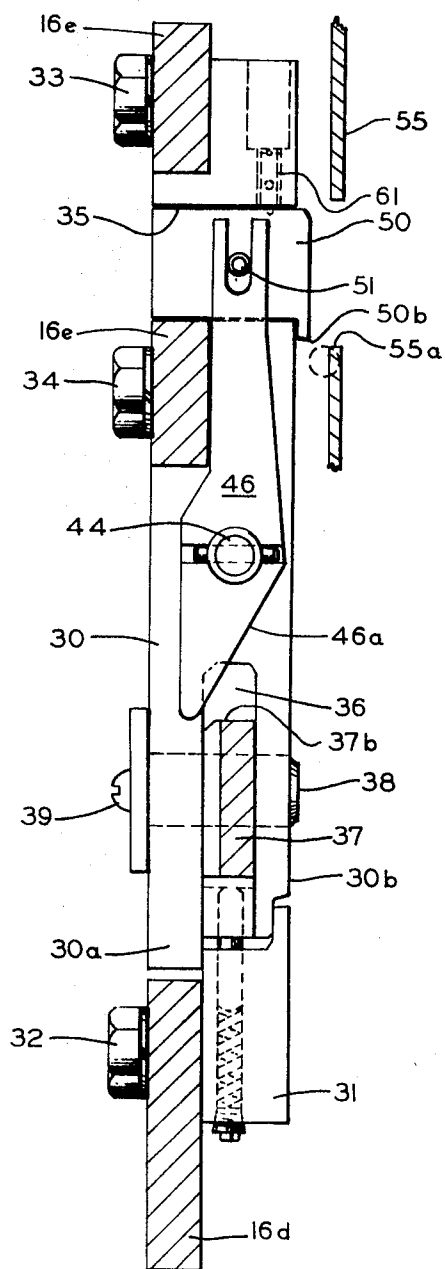


FIG. 4

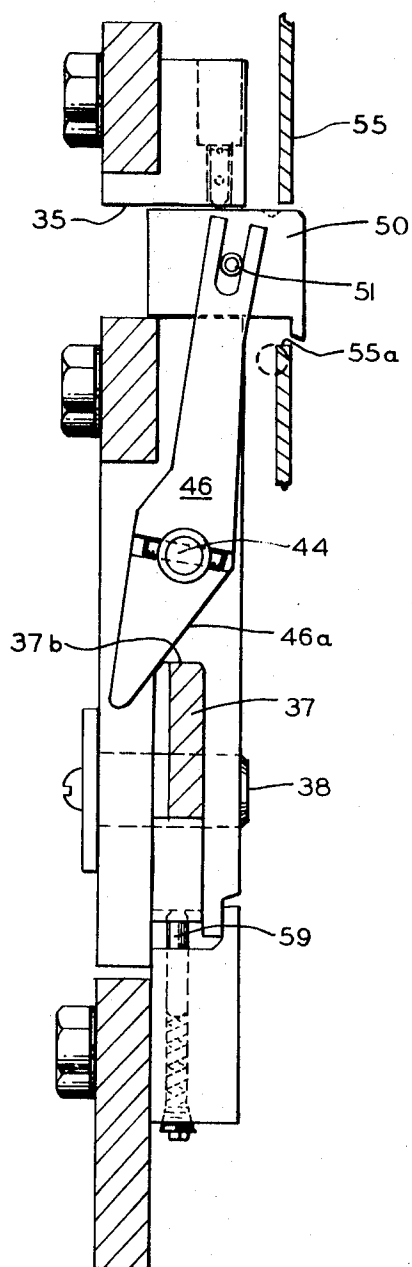


FIG. 5

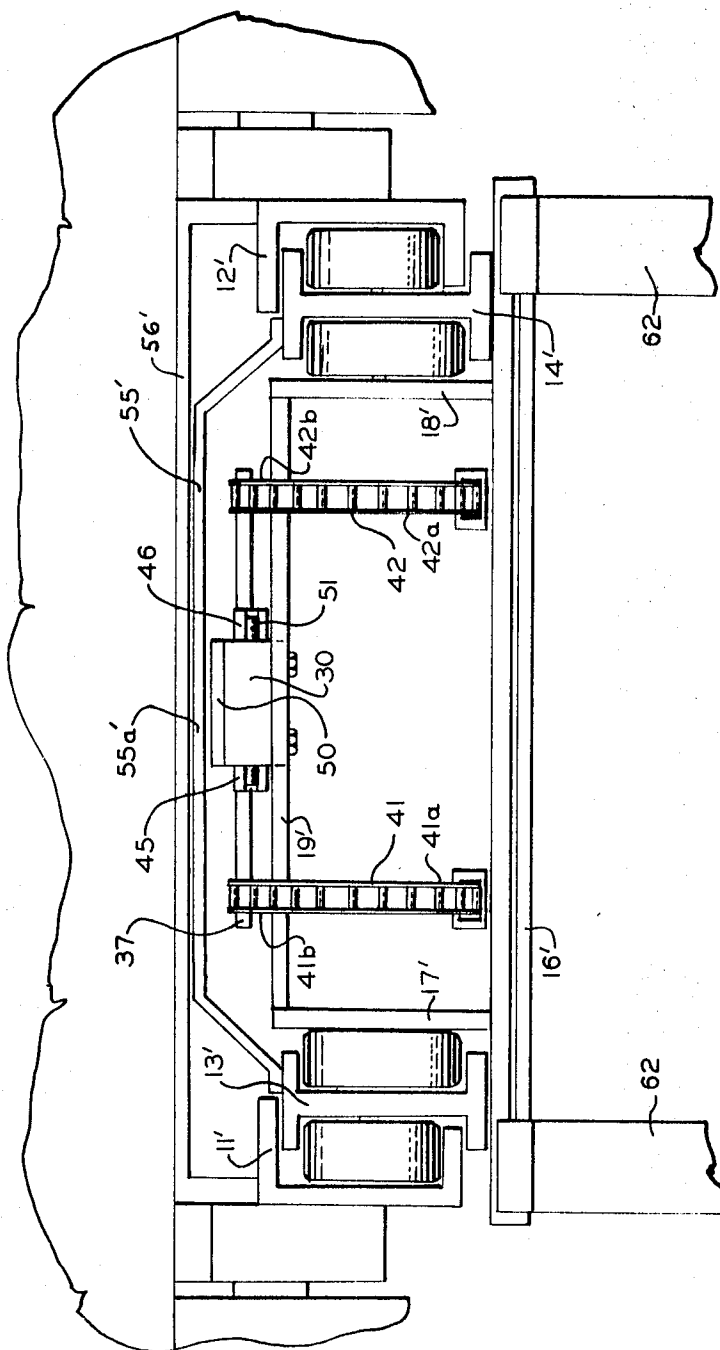


FIG. 6

LIFT TRUCKLOAD CARRIAGE SAFETY DEVICE

My invention relates to a safety device for limiting the fall of a lift truck load carriage if one or both of the chains or cables used to raise and lower the carriage should break. Many forklift trucks raise and lower loads by means of a pair of forks which extend horizontally from a load carriage which slides up and down between a pair of vertical beams or channels of a lift track mast structure. The load carriage commonly is raised by means of a pair of roller chains reaved over respective pulleys, with one end of each chain anchored to the frame of the truck and the other end attached to the load carriage, and hydraulic pistons raise and lower the load carriage and its forks by raising and lowering the pulleys. The chains are subject to wear and occasional breakage which can result in uncontrolled or free falling of a heavy load, and consequent damage to the load, and sometimes serious injury to surrounding personnel. One primary object of the invention is to provide a safety arrangement which will check or stop the free fall of a load carriage in the event of failure of one or both of the chains, to prevent such damage and injury. An attendant object is to provide an arrangement which will check the fall of the load carriage promptly after occurrence of such a failure, before the load carriage, forks and load can accelerate downwardly more than a limited distance.

Many lift truck mast structures use telescoping mast sections and are capable of raising loads to considerable heights. A chain can fail, of course, at any raised carriage position, and it is important that the safety system promptly stop fall of the carriage irrespective of the carriage height at the time when chain failure occurs. Thus it is one object of the invention to provide a chain-failure safety device which will promptly interrupt free fall of the load carriage no matter what the position of the carriage is at the time the chain failure occurs. It is another object of the invention to provide a chain-failure safety device which is effective irrespective of where the break occurs in the length of a chain which fails. Furthermore, it is desirable that the safety system not interfere with telescoping of the mast system, and it is desirable in the case of riding-operator trucks that parts of the safety system be of small size and not interfere appreciably with operator visibility between the uprights of the mast system.

It is also important that the safety system be extremely reliable and certain to function in the event of chain failure, but also certain not to stop or lock the load carriage in the absence of chain failure, and further important that the safety system not require adjustment and that it be incapable of getting out of adjustment.

Other objects of the invention will in part be obvious and will, in part, appear hereinafter.

The invention accordingly comprises the features of construction, combination of elements, and arrangement of parts, which will be exemplified in the construction hereinafter set forth, and the scope of the invention will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention reference should be had to the following detailed description taken in connection with the accompanying drawings, in which:

FIG. 1 is a front view of a lift truck utilizing the present invention.

FIG. 2 is a downward view of a lift truck utilizing the present invention taken at lines 2—2 in FIG. 1.

FIG. 3 is a front view taken at lines 3—3 in FIG. 2 illustrating the manner in which the lifting chains are connected to the load carriage in accordance with the invention.

FIG. 4 is a side view taken at lines 4—4 in FIG. 3.

FIG. 5 is a side view similar to FIG. 4 showing the positions which various parts of the apparatus assume upon occurrence of chain failure.

FIG. 6 is a view similar to FIG. 2 showing the application of the invention to a truck having a different form of mast and load carriage arrangement.

The lift truck shown in FIGS. 1 and 2 includes a base 10 upon which are mounted a pair of stationary upright outwardly facing channel mast members 11 and 12 rigidly affixed to the truck base 10. A pair of telescoping I-beam mast members 13 and 14 are nested within mast channels 11 and 12, respectively, and rollers 15, 15 journaled at several places along the length of mast channels 11 and 12 guide I-beam mast members 13 and 14 so that they may be raised and lowered relative to fixed mast channels 11 and 12. The two telescopic I-beam members are tied together by several braces, as shown at 13a and 13b in FIG. 1, and by a cover plate 55 which extends along most of the length of the I-beams.

Load carriage 16 comprises a rectangular boxlike structure having an upright plate 16a, two vertical side braces 16b, 16c, and two lower cross braces 16d and 16e. The load carriage may carry a forwardly extending platform 16f, or any one of a variety of known load manipulators (not shown). Two plates 17 and 18 (FIG. 2) extend rearwardly from carriage 16, and rollers journaled in plates 17 and 18 seat within the flanges of I-beam mast members 13 and 14 to guide carriage 16 as it is raised and lowered relative to I-beam mast members 13 and 14. Two chains 41 and 42 are reaved over pulleys mounted at the top of the telescopic I-beam structure as shown in FIG. 1. The rear end of each chain is fixedly attached to base structure of the truck, and the front end of each chain connects to load carriage 16 through the safety device to be described. A hydraulic piston-cylinder CYL raises and lowers the telescopic mast structure, thereby raising and lowering load carriage 16. Drive motor equipment, batteries, etc., which are carried on base 10 of the truck toward the rear end of the truck are indicated generally at 10a in FIG. 1.

Chain failure may occur at any time, of course, either while the load carriage is being lifted or lowered or while it is still. If the load carriage is empty or lightly loaded when one chain fails, the remaining chain may be capable of supporting the carriage, although it is highly desirable that the truck not be operated with one broken chain. If the load carriage is heavily loaded when one chain fails, the added load imposed on the remaining chain may cause the remaining chain to fail shortly thereafter, depending upon the load, and the forces imparted to the load carriage by lifting and lowering or motion of the truck.

As best seen in FIGS. 3 and 4, the safety device includes a vertically extending plate 30 having a lower front end 30a which terminates adjacent bottom cross brace 16d of the load carriage and a lower rear end 30b which is clamped to cross brace 16d by means of pad 31 and bolts 32, 32. Bolts 33, 33 and 34, 34 attach the upper end of plate 30 to carriage cross brace 16e, both above and below slot 35 in brace 16e.

Plate 30 is provided with transverse slot 36 across its width, and rocker arm 37 extends through slot 36 and is pivotally mounted therein on stub shaft 38, a front flange of which is affixed to plate 30 with screws 39, 39. The two lengths of roller chain 41, 42 which suspend load carriage 16 extend downwardly from above and are fixedly attached to opposite ends of rocker arm 37, at equal lever arm distances from shaft 38. With equal tension in the two chains, it will be seen that rocker arm 37 will lie in the level or centered position shown in FIG. 3. If chain 41 breaks, so that the entire load is supported by chain 42, it will be seen that rocker arm 37 will rapidly rotate counterclockwise as viewed in FIG. 3, until bottom edge 37a strikes the top of pad 31. Conversely, if chain 42 breaks, so that the entire load is supported by chain 41, it will be seen that rocker arm 37 will rapidly rotate clockwise, until bottom edge 37c strikes the top of pad 31.

Pivot shaft 44 extends horizontally through and is journaled in plate 30, and lever arms 45 and 46 are fixedly mounted on opposite ends of shaft 44 by means of pins 47, 47. The lower ends of lever arms 45 and 46 are each provided with a cam surface portion which extends obliquely to the plane of rotation of rocker arm 37, the cam surface portion or edge of lever arm 46 being indicated at 46a in FIG. 4. Counterclockwise rotation (as viewed in FIG. 3) of rocker arm 37, such as would

occur by failure of hoisting chain 41, will be seen to result in clockwise rotation (as viewed in FIG. 4) of lever arm 46 as upper edge 37b of rocker arm 37 cams edges 46a generally leftwardly in FIG. 4. The upper end yoke of pivot arm 46 engages dowel pin 51 extending from stop block 50, thereby translating block 50 rightwardly as viewed in FIG. 4, out from its retracted position within slot 35 of cross brace 16e. The rotation of shaft 44 by arm 46 simultaneously rotates arm 45, and its yoke end similarly urges stop block 50 rearwardly, to the right as viewed in FIG. 4, so that block 50 enters opening 55a in cover plate 55. The engagement of block 50 with the opening in plate 55 will be seen to abruptly halt the fall of load carriage 16. It may be noted that the parallel and lower edges of slot 35 angularly align block 50 about the axes of pins 51 so that the rear face of stop block 50 is initially parallel to, and remains parallel to, the plane of cover plate 55 of the telescopic mast structure. Clockwise rotation (as viewed in FIG. 3) of rocker arm 37, such as generally occur by failure of hoisting chain 42 will be seen similarly to provide rearward displacement of stop block 50 as edge 37d of the rocker arm cams lower surface 45a (not shown) of arm 45 generally forwardly, thereby pivoting arm 45, shaft 44 and arm 46 all clockwise as viewed in FIG. 4. Thus in the case of a single chain failure, irrespective of which chain fails, stop block 50 is rapidly moved rearwardly, to the right as viewed in FIG. 4.

The rigid cover plate 55 is fixedly attached to the telescopic mast structure which the load carriage moves relative to, and extends substantially the entire height of the structure. Cover plate 55 is provided with a plurality of recesses or openings 55a, 55b, etc., to provide cooperating stop means to engage stop block 50. In one embodiment of the invention the successive openings were spaced vertically at a distance of about 14 inches from each other, although closer or wider spacings well may be preferred in various applications. The maximum spacing determined by the maximum distance which the maximum load may be allowed to freely fall without gaining a prohibitive amount of kinetic energy, and the minimum spacing is determined by the weight or thickness of cover plate 55 and how close together the successive recesses may be spaced without unduly weakening the cover plate. While a single cover plate having a series of openings is shown in FIGS. 1-5, it will be apparent that the same operation may be obtained by using a plurality of bars or plates extending across the telescopic mast structure in lieu of one large plate, and the use of a number of bars vertically spaced, 12 inches apart, for example, is particularly desirable where the provision of operator visibility through the mast structure is deemed important.

A chain may fail during any raised position of the load carriage, of course, and specifically, at a time when load carriage position does not result in stop block 50 being adjacent a cover plate recess. In such a case, arms 45 and 46 immediately urge stop block 50 rearwardly against the front side of cover plate 55. The load carriage continues to move, with the stop block rubbing against the cover plate, but after a limited amount of movement, e.g., no more than 16 inches with the exemplary cover plate recess spacing mentioned, the stop block arrives adjacent to and enters a cover plate recess, locking the load carriage in position relative to the hoist structure.

If heavy load is being carried by the load carriage, failure of one chain may impart such an added load to the remaining chain that it also may break substantially simultaneously. If both chains break substantially simultaneously neither chain may be able to rotate rocker arm 37 to project stop block 50. To avoid a free fall of the load carriage in such an event, compression spring 56, which is held within a bore 57 in pad 31 by means of plug 58, urges dowel pin 59 against a lower edge 37e of rocker arm 37. The length and force spring 56 and its lever arm distance from shaft 38 are arranged so that the empty weight of the load carriage and forks provide sufficient tension in chains 41 and 42 to normally hold rocker arm 37 in its horizontal or centered position. Upon failure of both chains substantially simultaneously, however, spring 56 rotates

rocker arm, counterclockwise as viewed in FIG. 3, projecting stop block 50 in the same manner as if chain 42 alone had failed.

Routine material-handling operations usually require that a load carriage or load forks frequently be lowered to the floor. While most material-handling trucks incorporate lifting chain or cable arrangements which prevent the chains or cables from becoming slack when the load carriage rests on the floor, a few do not. It would be quite undesirable, of course, for the carriage to be locked each time the forks were fully lowered. In accordance with the invention, even through spring 56 rotates, rocker arm 37 and stop block 50 is projected each time the chains become slack, the load carriage may be prevented in such trucks from being locked in that position by the simple expedient of providing no recesses in cover plate 55 adjacent the lowermost position of stop block 50. Thus spring 56 then will merely urge stop block 50 against a flat, smooth front surface of cover plate 55. Then as lifting of the load carriage begins and chains 41, 42 are tensioned, they restore rocker arm 37 to its centered position, overcoming the force of spring 56 and retracting stop block 50.

When stop block 50 is in its retracted position a spring-biased plunger 61 engages a small recess in the top of block 50 to act as a detent, preventing vibration and inertia from rotating arms 45 and 46 or accidentally moving block 50 from its retracted position. Spring 56 (FIG. 3) must be made strong enough to overcome detent 61, of course, in the case of failure of both chains. A lower lip 50b of block 50 seats against plate 30 to limit retraction of block 50.

The provision of parallel upper and lower edges in slot 35 and cooperating parallel upper and lower faces on stop block 50, together with the sliding yoke-pin interconnections of arms 45, 46 to block 50 will be seen to result in block motion perpendicular to cover plate 55 when a chain fails. It is possible to connect arms 45 and 46 to block 50 using fixed pivots if slot 35 is slightly enlarged so that block 50 will be rotated toward cover plate 55 about the axis of shaft 44 rather than being translated normal to plate 55, but the arrangement shown is preferred because it insures that the rear face of block 50 will remain parallel to the face of the cover plate, so the edge of an opening on the cover plate cannot engage an oblique face of block 50 and tend to push block 50 back toward its retracted position.

The mast system of the truck illustrated in FIGS. 1-5 differs from the arrangement utilized in most lift trucks in that the telescopic I-beam are mounted outside rather than inside of the fixed channel uprights, and in that the load carriage rides on the outside rather than the inside of the telescopic I-beam members. It is important to note, however, that the invention is equally applicable to the more common type of mast arrangement, as is illustrated by FIG. 6, a plan view of a typically truck mast structure. In FIG. 6 load carriage 16' shown carrying load forks 62,62 includes a rearwardly extending frame including arms 17', 18' and bar 19' all rigidly affixed to carriage 16' near the top of the carriage. Similar bars (not shown) mounted directly beneath 17', 18' and 19' extend rearwardly from near the bottom of load carriage. The front ends 41a, 42a of chains 41, 42 fixedly attach to the truck base structure, and the rearward ends 41b, 42b of the chains attach to the ends of rocker arm 37 of the safety device, the plate 30 of which is fixedly bolted to both bar 19' and the similar bar below bar 19'. Upon failure of one or both of the chains, block 50 is urged rearwardly, so that it will intercept bar 55', one of a number of bars which extend from one telescopic I-beam mast 13' to the other mast 14'. Bars similar to 55' are vertically spaced along the I-beams approximately one every 16 inches. As block 50 strikes the top of a bar such as 55' downward motion of load carriage 16' relative to the telescopic I-beam mast structure will be halted, in the same manner as in the previous embodiment.

While the device of FIGS. 1-5 halts free fall of the load carriage by locking it to the telescopic mast structure, which is supported by the hydraulic cylinder, it is possible and within

the scope of the invention to have the load carriage stopped by block 50 intercepting fixed structure. For example, it will be seen in FIG. 6 that with obvious changes in dimensions to relocate the safety device slightly rearwardly, that bar 55' and the similar bars spaced below it can be eliminated, and their function performed by similar bars (or a cover plate with openings) which extend between the fixed upright masts 11' and 12' in the manner shown at 56', and which are spaced at appropriate intervals along fixed upright masts, 11' and 12'. Such an arrangement has the apparent disadvantage, when compared to the specifically disclosed arrangement, that the load carriage could fall the entire length of the telescopic uprights before engaging a stop if chain failure occurs when the load carriage is fully elevated. The use of stops on the fixed uprights may be satisfactory for certain applications where fairly light loads are carried, however, and on trucks which do not incorporate telescoping uprights between the fixed uprights and the load carriage.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained, and since certain changes may be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a lift truck hoist mechanism having a load carriage connected to be raised and lowered relative to a vertically extending mast structure by means of a pair of flexible cable means from which said carriage is suspended, the combination of an arm pivotally mounted on said carriage and connected to be rotated from a reference position upon occurrence of substantially different amounts of tension in the two cable means, each of said cable means being connected to said arm on a respective side of the pivot point of said arm whereby failure of one of said cable means causes rotation of said arm in first angular direction from said reference position with a torque commensurate with the weight of the load carriage and a load carried thereby or failure of the other of said cable means causes rotation of said arm in an opposite direction from said reference position with a torque commensurate with said weight, a first stop means, rigid lever means pivotally mounted on said carriage and spaced adjacent said arm so that said arm strikes said lever means whenever said arm is angularly displaced predetermined distances in either direction from said reference position and thereafter pivots said rigid lever means with a torque commensurate with said weight upon further displacement of said arm, said first stop means being connected to said lever means whereby said first stop means is urged toward a first position with a force commensurate with said weight, and a plurality of cooperating stop means spaced along said vertically extending structure, each of said cooperating stop means being engageable with said first stop means when said first stop means is located vertically adjacent one of said cooperating stop means and is being urged toward said first position, whereby upon failure of one of said cable means said first stop means engages the first of said cooperating stop means to which it becomes adjacent and locks said carriage in a fixed position relative to said vertically extending mast structure.

2. The combination according to claim 1 in which said mechanism includes spring means arranged to act between said load carriage and said first means to urge said first means away from said reference position, the empty weight of said load carriage causing sufficient tension in said cable means in the absence of failure of said cable means to overcome the force of said spring means, but whereby said spring means is operative to rotate said means away from said reference position upon failure of and loss of tension in both of said cable means.

3. The combination according to claim 1 in which said vertically extending mast structure comprises a fixed mast struc-

ture and a telescoping vertically movable mast structure adapted to be raised and lowered relative to said fixed mast structure, and in which said plurality of cooperating stop means are spaced along said vertically movable mast structure.

4. The combination according to claim 1 in which said vertically extending mast structure comprises a fixed mast structure and a telescoping vertically movable mast structure adapted to be raised and lowered relative to said fixed mast structure, and in which said plurality of cooperating stop means are spaced along said fixed mast structure.

5. The combination according to claim 1 having spring-dependent means for maintaining said first stop means in a reference position in the presence of vibration in the absence of failure of one or both of said cable means.

6. The combination according to claim 1 having means for preventing rotation of said first stop means as said first stop means engages any of said cooperating stop means.

7. In a hoist mechanism having a load carriage connected to be raised and lowered relative to a vertically extending structure by means of a pair of flexible cable means which said carriage is suspended, in which failure of one or both of said flexible cable means creates an unsafe condition, the combination of a first arm pivotally mounted on said carriage, each of said cable means being connected to said first arm on an opposite side of the pivot point of said first arm and each being connected to said first arm at the same lever arm distance from said pivot point, whereby substantially equal tension on said cable means positions said first arm substantially at a reference angular position about said pivot point and failure of one or the other of said cable means causes said first arm to be pivoted in one direction or the other from said reference angular position with a torque commensurate with the weight of said load carriage and the load carried thereby; movable stop means including lever means pivotally mounted on said carriage and a first stop means connected to said lever means, said lever means being spaced from portions of said first arm on opposite sides of said pivot point to be engaged by one or the other of said portions of said first arm upon predetermined rotation of said first arm in one direction or the other from said reference angular position, so that predetermined rotation of said first arm in either direction from said reference angular position pivots said lever means and translates said first stop means in a predetermined direction to a stop position with a force commensurate with said weight; and a plurality of cooperating stop means fixedly spaced along said structure to be engageable by said first stop means when said first stop means is in said stop position, whereby upon failure of one of said cable means said first stop means engages the first of said cooperating stop means which it passes and locks said load carriage in a fixed position relative to said vertically extending structure.

8. A lift truck hoist mechanism, comprising, in combination: a mast structure including a pair of vertically extending mast members laterally spaced apart from each other, each of said members having a pair of laterally extending flanges; a load carriage connected to be raised and lowered relative to said mast members, said load carriage extending between said mast members and carrying a plurality of rollers nested between said pairs of flanges of said mast members; load-engaging means affixed to said carriage and extending longitudinally from said load carriage beyond said mast members; an arm pivotally mounted on said carriage to pivot about a substantially longitudinal axis; a pair of flexible cable means adapted to raise and lower said carriage, each of said cable means being connected to said arm on an opposite side of the pivot point of said arm, whereby failure of one or the other of said cable means causes rotation of said arm in one or the other of two angular directions from a reference position for said first arm; lever means pivotally mounted on said carriage to pivot about a substantially lateral axis, said lever means being spaced from said arm so that rotation of said arm in said one angular direction from said reference position of said arm

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causes said lever means to pivot in a given angular direction from a reference position of said lever means and rotation of said arm in said other angular direction from said reference position of said arm causes said lever means to pivot in said given angular direction from said reference position of said lever means; a first stop means connected to said lever means to be translated longitudinally in a direction perpendicular to a line between the two supporting mast member as said lever means is pivoted in said given angular direction; and a plurality of cooperating vertically spaced stop means spaced along said mast structure to be engaged by said first stop means

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when said first stop means is translated longitudinally.

9. A hoist mechanism according to claim 8 wherein all of said cooperating stop means are located longitudinally on one side of said mast structure.

5 10. A hoist mechanism according to claim 8 having a recess for slidably supporting said first stop means and preventing rotation of said first stop means, said first stop means being connected to said lever means by a pin-and-slot connection, whereby rotation of said lever means causes translation of said
10 first stop means without rotation of said first stop means.

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